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Could negative affect be 'part' of the 'whole' picture in weak central coherence? *A study of weak central coherence and its relation to affect and autistic traits*

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Abstract

Weak Central Coherence (WCC) is recognised as a major cognitive theory of Autism Spectrum Disorder (ASD) and is characterised by a processing bias for local information. Furthermore, individuals with ASD have been found to be more susceptible to depression and lower mood. Considering negative mood seems to result in better performance on detail-based processing tasks, the present study suggests that WCC could be a result of high levels of negative affect in ASD. This was explored in two experiments using a non-clinical sample with autistic traits. Experiment 1 involved manipulating mood, whereas Experiment 2 was a longitudinal study. The study's findings were inconclusive, although some promising results were found for future research and the potential role of affect in WCC.

Ethical Statement

The present study was conducted in accordance to the ethical guidelines of the University of Plymouth and the British Psychological Society's Standing Committee of Ethics in Research with Human Participants. Ethical clearance was granted and the study adhered to these guidelines in both principle and practice.

All participants were fully briefed and informed of their right to withdraw from the study at any time. They were also told that they have the right to have their data removed from the study and destroyed upon request. Before participating in the experiment, each participant was required to agree to the informed consent. All of the participant's details and data remained confidential at all times, which was made aware to the participants during the brief. Only the researcher and supervisor were aware of who participated in the study.

All measures were taken to ensure that both the participant and researcher were protected from harm at all times. In order to counteract the effect of the negative mood induction, participants were played a piece of music during the debrief (Mozart's Eine Kleine Nachy Musik) which studies have shown produces positive mood. Participants were also assured that the Autism-Spectrum Quotient is not a diagnostic tool and even a high score is not indicative of a diagnosis of autism. However, if they had any concerns regarding any of the issues raised during the study, the details of the university's counselling service was provided on the debrief.

All participants received a thorough debrief explaining to them that the study was investigating autistic traits and mood. Background information on the area of investigation was provided as well as the aims of the study. All participants had an opportunity to ask questions and were given a written debrief containing the details of the study and contact details for the researcher and supervisor.

All data was collected independently and then combined with data collected by Rebecca Day to form a larger sample. However, the statistical analysis and write-up was completed separately.

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Introduction

Since autism spectrum disorder (ASD) was first identified by Kanner (1943), researchers have strived to uncover the specific aetiology of this condition, in an attempt to understand its diverse spectrum of associated outcomes (Schroeder, Desrocher, Bebko, & Cappadocia, 2010). However, over several decades of research, the aetiology for most cases of ASD remains unknown (Russell, Kelly, & Golding, 2009). Even so, three cognitive theories of ASD have dominated this area of psychological research and proved popular amongst researchers (Rajendran & Mitchell, 2007). These are Theory of Mind (ToM; Baron-Cohen, 1989), Theory of Executive Dysfunction (Ozonoff, Pennington, & Rogers, 1991) and Weak Central Coherence Theory (WCC; Frith & Happé, 1994; Happé, 1999). Happé and Frith (2006) described WCC as a “processing bias for featural and local information, and relative failure to extract gist or ‘see the big picture’ in everyday life”. Although the underlying mechanism in WCC has been greatly debated (Noens & van Berckelaer-Onnes, 2008), one proposed explanation is that there is a deficit in the central mechanism responsible for the integration of information in ASD (López, Leekam, & Arts, 2008). In the present study, the underlying mechanism of WCC is questioned and an alternative hypothesis is proposed suggesting that negative affect contributes towards this processing style.

ASD is considered a complex neurological disorder which is characterised by a triad of impairments in social interaction, communication and imagination (Wing, 1993). Throughout development, these impairments can vary significantly from person-to-person which resulted in autism being considered a disorder on a spectrum (Noriega, 2008). Some of the difficulties in social interaction and communication can be explained by a deficit in ToM, which may be a result of difficulties understanding and predicting other people’s behaviour in terms of beliefs and reasons (Baron-Cohen, 1989; Zalla, Sav, Stopin, Ahade, & Leboyer, 2009). However, social difficulties seen in ASD could also be explained by abnormalities in information processing, such as WCC (Le Sourn-Bissaoui, Caillies, Gierski, & Motte, 2011). Research has suggested that WCC is distinct from ToM as detail-based processing can be found across the autistic spectrum, regardless of ToM performance (Happé & Frith, 2006). The term ‘coherence’ itself refers to the tendency to integrate information in context for higher level meaning, usually at the expense of attending to featural information (Booth & Happé, 2010). ASD seems to be characterised by a weak drive for global coherence, in which individuals with ASD seem to display a tendency to process information locally and fail to extract context-dependant meaning (Frith & Happé, 1994; Happé, 1994). This processing bias has been found to result in marked disadvantages in tasks which involve interpreting individual stimuli in terms of overall context and meaning (Frith & Happé, 1994). An example of this is the processing of faces. Considering the social significance of facial expressions in social interaction, impaired facial processing skills may contribute towards some of the observed social difficulties found in ASD (Farran, Branson, & King, 2011). As face recognition seems to require global processes, individuals with ASD appear to perform poorer at recognising facial expressions when the demands for global processing were higher, which is consistent with the WCC hypothesis (Kätsyri, Saalasti, Tiippana, von Wendt, & Sams, 2008), although conflicting findings to this claim have also been found (e.g. López, Donnelly, Hadwin, & Leekam, 2004).

Various explanations have been proposed regarding the underlying mechanism of WCC in ASD. As previously mentioned, one such explanation suggests that there is a deficit in the central processing mechanism responsible for integrating information together (Frith, 2003). This process can be subdivided into integrating information at the conceptual level (e.g. semantic memory tasks) or the perceptual level which involves the integration of visual information (e.g. face processing tasks) (López et al., 2008). The notion of integrative difficulties resulting in WCC is partially supported by the 'underconnectivity' theory proposed by Just, Cherkassky, Keller, and Minshew (2004). Using functional magnetic resonance imaging (fMRI), Just et al. (2004) found reduced functional connectivity in individuals with ASD. Consequently, they suggested that underfunctioning of the integrative circuitry responsible for assimilating information at the neural level, could be responsible for various symptoms of ASD, providing a potential biological explanation for WCC. However, selective attention research has found that when participants with ASD are instructed to attend to the global features of a task, they are able to do so, thus eliminating their local processing advantage (Plaisted, Swettenham, & Rees, 1999). This finding suggests that individuals with ASD can process information globally when instructed to do so, but process locally when not told otherwise (van Lang, Bouma, Sytema, Kraijer, & Minderaa, 2006). Consequently, attention (or perception) itself could help explain the mechanisms of WCC in which the focus of attention may affect the processing of particular stimuli or the integration of distinct features (Plaisted, Saksida, Alcántara, & Weisblatt, 2003). This is explained as a deficit in the ability to broaden attention (zoom out), or shift from local to global processing (Mann & Walker, 2003). The suggestion is that both global and local processing can be performed, but that individuals with ASD have more difficulties and are slower to 'zoom out' from processing a small stimulus to a larger stimulus (White, O'Reilly, & Frith, 2009). This difficulty may also reflect impairments in executive functions such as inhibitory control, planning ahead and as previously mentioned, shifting from a local to global focus (Booth, Charlton, Hughes, & Happé, 2003). This has been tested using samples possessing impaired executive function, such as individuals with attention-deficit hyperactivity disorder (ADHD). Research has found that individuals with ADHD also display poor planning, shifting and monitoring as well as marked impulsivity, providing evidence for the executive dysfunction account of WCC (Booth & Happé, 2010).

WCC has also been proposed to be an underlying feature of other characteristic ASD symptoms such as insistence for sameness/routine, attention to parts of objects, and an uneven cognitive profile (Booth & Happé, 2010). A link has also been found between WCC and certain 'islets of ability' in areas such as maths, music and art, in which localised processing appears advantageous (Happé & Vital, 2009). Further research has also suggested other advantages which can be gained from having a featural processing bias. Individuals with ASD seem to display enhanced performance on visuospatial tasks compared to controls, particularly with regards to tasks which require focussing on parts of a complex stimulus (O'Riordan, 2004; Pellicano, 2010). One such task is the Embedded Figures Test (EFT), which involves identifying a simple target shape, within a complex background/figure (Drake, Redash, Coleman, Haimson, & Winner, 2010). The EFT was originally designed as a measure of 'field independence' (FI) which refers to a cognitive style characterised by the tendency to see objects in ones field of vision as discrete units, opposed to seeing it as a whole (Glicksohn, Naftuliev, & Golan-Smooha, 2007). FI is therefore defined by good EFT performance, however, a suggested difference to WCC is that FI people can see, but resist the gestalt, whereas those with WCC do not attend to the gestalt and see the figure in terms of its parts (Happé & Frith, 2006). Even so, good EFT performance is recognised as an accurate measure of WCC (Pellicano, 2010). Compared to matched controls, numerous studies have found that individuals with ASD seem to perform better on the EFT (Jarrold, Gilchrist, & Bender, 2005; Jolliffe & Baron-Cohen, 1997). As the EFT draws upon the natural bias towards local processing in ASD, typically developing individuals are slower and less accurate because disembodied visual processing conflicts with their own natural bias which is to attend to the gestalt (Lee, Foss-Feig, Henderson, Kenworthy, Gilotty, Gaillard, & Vaidya, 2007). Research has also examined the relationship between autistic traits and enhanced performance on visuospatial tasks involving detail-based processing. Consistent with WCC theory, parents of autistic children and individuals with high autistic traits have been shown to adopt a more localised processing style and perform faster and more accurately on the EFT (Almeida, Dickinson, Maybery, Badcock, & Badcock, 2010; Bölte & Poustka, 2006; Grinter, Van Beek, Maybery, & Badcock, 2009; Walter, Dassonville, & Bochsler, 2009). Gender differences have also been found in which males appear to perform better at visuospatial tasks with an apparent bias for local processing, resulting in enhanced EFT performance (Baron-Cohen, 1998). Considering ASD is far more prevalent in males (occurring four to eight times more frequently), this has led to the suggestion that ASD itself is an extreme form of the normal male brain (Baron-Cohen & Hammer, 1997; Hughes, 2009). Consequently, ‘male superiority’ in EFT performance seems to support the evidence that individuals with ASD appear to show a local processing bias.

Just as the perceptual biases in ASD differ to typically developing individuals, so too does their functional anatomy whilst completing the EFT. In a study using fMRI, normal controls seem to display more task-related activations and additional prefrontal activation, compared to participants with ASD who demonstrated no prefrontal activation and greater activation of the ventral occipito-temporal regions (Ring, Baron-Cohen, Wheelwright, Williams, Brammer, Andrew, & Bullmore, 1999). These results seem to suggest that the cognitive strategy employed by typically developing individuals involves a greater contribution from working memory systems, whereas those with ASD seem to rely more on visual systems for object feature analysis (Ring et al., 1999). This research suggests a neural basis for WCC, which was explored further in a study by Lee et al. (2007). Using fMRI, they observed reduced prefrontal involvement in ASD which is consistent with the suggestion that weak ‘top-down’ processing promotes WCC in ASD. Many features of ASD appear to be manifestations of reduced top-down processing, suggesting that local processing may be the default when executive function is weakened or absent (Frith, 2003). Further research suggests that bottom-up processing (which is associated with detail-based processing) is relatively preserved in ASD, whereas top-down input is impaired (Maekawa, Tobimatsu, Inada, Oribe, Onitsuka, Kanba, & Kamio, 2011). In contrast, evidence has also been found for enhanced bottom-up processing in WCC, in which the debate between each view remains ongoing (Noens & van Berckelaer-Onnes, 2008).

Another factor which seems to influence whether a localised or global processing style is employed is affective states (Clore & Huntsinger, 2007; Storbeck & Clore, 2005). Gasper & Clore (2002) found that when adult participants were induced into a sad mood, they were less likely than those in happier moods to adopt a global processing style or classify stimuli based upon global features. A similar finding was found by Schnall, Jaswal, and Rowe (2008) who investigated the effect of mood on information processing in children. They found that happiness seems to promote a top-down processing style, which could be detrimental when attention to detail is required. Furthermore, using the EFT, they also found that children induced into a happy mood were slower to locate a target shape and found fewer, compared to those induced into a sad mood. Consequently, these studies seem to suggest that positive moods promote global (top-down) processing whereas negative moods seem to promote local (bottom-up) processing. These findings seem consistent with the ‘level-of-focus’ principle (derived from the affect-as-information approach) which suggests that affective feedback should influence the focus of processing, resulting in positive moods promoting attention to global features of a stimuli and negative moods promoting attention to the local aspects (Avramova, & Stapel, 2008; Clore, Gasper, & Garvin, 2001). Consequently, if all seems to be well, a global, top-down information processing style is adopted, whereas sadness may infer that something is wrong, resulting in detail-focused processing (Schnall et al., 2008). The suggestion that negative moods may promote detail-based processing may have vast implications with regards to understanding the mechanisms of WCC in ASD. To examine this fully, first the relationship between ASD and mood will be discussed.

Compared to typically developing individuals, those with ASD and sub-clinical autistic traits seem to be more frequently diagnosed with depression and anxiety disorders (Ingersoll & Hambrick, 2011; Ketelaars, Horwitz, Sytema, Bos, Wiersma, Minderaa, & Hartman, 2008; Kunihira, Senju, Dairoku, Wakabayashi, & Hasegawa, 2006; Meyer, Mundy, Van Hecke, & Durocher, 2006). Furthermore, depression also appears to have the highest rate of comorbidity in ASD (Shtayermman, 2007). However, the process of identifying depressive symptoms can be problematic, due to the associated difficulties autistic people have in describing emotional states, or using expressive language (Sterling, Dawson, Estes, & Greenson, 2008). As a result, although low mood itself is often described as the most common symptom of depression in people with ASD, it is usually reported by a parent, or observed by behavioural changes (Kannabiran & McCarthy, 2009). This procedure was used in a study by Mazefsky, Conner, and Oswald, (2010) in which they asked parents of children with ASD to complete the Autism Comorbidity Interview. They found that approximately 75% of participants could be correctly classified as having a depressive or anxiety disorder. Further research has also found that teacher and self-report ratings of depression and anxiety amongst adolescents with ASD were greater than parent’s ratings (Hurtig, Kuusiikko, Mattila, Haapsamo, Ebeling, Jussila, Joskitt, Pauls, & Moilanen, 2009). This suggests that parents may underestimate their child’s emotional distress which could be greater than reported. The social difficulties associated with ASD are also likely to contribute towards a despondent mood in which low levels of perceived social competence appear to be associated with depressive symptoms (Lee, Hankin, & Mermelstein, 2010). This seems likely to affect individuals with high-functioning ASD as, due to their higher intellectual capacity, they are more likely to perceive themselves as less socially competent compared to their peers (Vickerstaff, Heriot, Wong, Lopes, & Dossetor, 2007). This notion appears consistent with research which suggests that people with high-functioning ASD are more susceptible to depression, as they are more aware of their social deficiencies (Barnhill & Smith-Myles, 2001; Kim, Szatmari, Bryson, Streiner, &

Wilson, 2000). However, contradictory findings have also been found, suggesting that individuals with lower functioning ASD are more at risk (Rosbrook & Whittingham, 2010). Even so, a general consensus amongst researchers suggests that ASD is characterised by lower mood and a greater likelihood of developing depression.

Considering the aforementioned research, the current study aims to investigate the associations between ASD, affect and WCC. Based upon the findings that negative affect seems to result in enhanced local processing and individuals with ASD are more prone to low mood and depression, the present study hypothesised that the high rates of negative affect in ASD, may contribute towards the detail-based processing style explained by WCC. A similar concept has been previously investigated in a study exploring the relations between WCC, ToM, and social-emotional functioning in a group of children with high-functioning autism (Burnette, Mundy, Meyer, Sutton, Vaughan, & Charak, 2005). Burnette et al. (2005) suggested that the influence of mood could help explain some of the discrepancies in the literature on WCC. Therefore, they hypothesised that increased anxiety would be associated with the tendency to adopt a localised processing style in children with autism. However, this study did not find any significant relation between WCC and social-emotional functioning. This could be due to the criteria used to assess ASD by Burnette et al. (2005), which specified that participants should have no general language delay. As a result, this description seems more applicable to Asperger's syndrome which differs from ASD based upon the absence of language impairments (Worth & Reynolds, 2008). Considering other studies have found individuals with Asperger's syndrome to not show a superiority effect on visuospatial tasks (e.g. Ropar and Mitchell, 2001), this could help explain the study's findings. Furthermore, as Burnette et al.'s study did not find WCC in autistic children, it is also questionable how they are able to draw conclusions about the mechanisms of WCC with regards to emotion. The present study aimed to develop the notion that affect may influence WCC by focusing more specifically on ratings of mood. This was investigated using two experiments in which a non-clinical sample was used. Previous research has suggested that individuals who do not meet the diagnostic criteria for autism but display high autistic traits, also seem to perform faster and more accurately on the EFT, and are more frequently diagnosed with depression and anxiety disorders (Grinter et al., 2009; Ingersoll & Hambrick, 2011). Furthermore, as ASD is considered to be on a continuum (or spectrum) with varying degrees of impairment (Stewart, Watson, Allcock, & Yaqoob, 2009), the use of a non-clinical sample to test this hypothesis seems justified.

In Experiment 1, the effect of positive and negative affect was investigated in which participants were induced into one of these two affective states (happy vs. sad condition). The main hypothesis for Experiment 1 suggested that participants who scored higher on autistic traits and were induced into a negative mood would score higher on the EFT. Experiment 2 was a longitudinal study in which participants natural fluctuations in mood were assessed once a week over a four week period. It was predicted that participants reporting high autistic traits, high levels of negative affect and low levels of positive affect, would score higher on the EFT. Furthermore, it is also hypothesised that findings from previous research will be replicated in the present study. Firstly, individuals possessing high autistic traits should report higher levels of negative affect and less positive affect (Ingersoll & Hambrick, 2011;

Kunihira et al., 2006; Rosbrock & Wittingham, 2010). Second, participants reporting higher levels of negative affect and lower positive affect should show enhanced local processing and EFT performance (Avramova, & Stapel, 2008; Gasper & Clore, 2002; Schnall et al., 2008). Finally, individuals reporting high autistic traits (specifically on the AQ 'attention to detail' subscale) should also show enhanced local processing and EFT performance (Almeida et al., 2010; Grinter et al., 2009, Walter et al., 2009).

Method

Experiment 1

Experiment 1 examined the effects of inducing participants from a non-clinical sample in to either a positive or negative mood (happy vs. sad condition). All participants were measured for autistic traits, their mood before and after the mood manipulation and completed two variations of the EFT.

Participants

Fifty six male (n=22) and female (n=34) undergraduate psychology students from the University of Plymouth (UoP) participated in Experiment 1. Participants were between the ages of 18 and 25 years (mean age=19.54, SD=1.72) and those with a history of mental health difficulties were excluded from the study. No other biographical data was recorded. Participants were recruited using the Plymouth Psychology Participation Pool and received course credit for taking part. Participants were randomly assigned to one of two conditions. Either the sad condition, in which participants experienced the negative mood manipulation (n=26), or the happy condition in which they experienced the positive mood manipulation (n=30). All participants provided informed consent before participating.

Materials

<u>Autism-Spectrum Quotient (AQ):</u> This self-report questionnaire is designed to measure the extent that adults with normal intelligence possess traits associated with ASD (Baron-Cohen, Wheelright, Skinner, Martin, & Clubley, 2001). The AQ contains 50 items, consisting of 5 subscales of behaviour: social skills, attention switching, attention to detail, communication and imagination. For each item, participants need to respond by rating how much a particular statement is like themselves. Each of the 5 subscales has a maximum score of 10 points, resulting in an overall AQ score being out of 50.

<u>Positive Affect Negative Affect Schedule (PANAS):</u> The PANAS is a self-report measure consisting of 10 negative items and 10 positive items (Watson, Clark, & Tellegen, 1988). Respondents are required to rate (using a 5 point scale) the extent they have experienced each affective item within a specified time (within this study, participants were asked to base their responses upon how they feel at the time of the experiment). The scale ranged from slightly/not at all (1 point) to extremely (5 points). A participant's overall PANAS score for either positive or negative affect is the summed score of their responses for the relevant items.

<u>Mood Manipulation:</u> Participants were asked to list either 10 things that make them sad (e.g. failing exams, or being alone), or 10 things which make them happy (e.g. socialising with friends, or winning at sports) to induce increased negative or positive affect respectively. Similar descriptive techniques have been used in other studies in

order to induce a particular affective state (e.g. Gasper & Clore, 2002). Mood manipulations which involve the use of imagination (e.g. Colibazzi, Posner, Wang, Gorman, Gerber, Yu, Zhu, Kangarlu, Duan, Russell, & Peterson, 2010) were avoided, due to the associations between high autistic traits and poor imagination (Claridge & McDonald, 2009).

Group Embedded Figures Test (GEFT): The GEFT is an adaption of the original embedded figures test which can be administered to multiple participants in one session (Oltman, Raskin, & Witkin, 1971). The test booklet consists of 3 sections in which the first contains 7 items and the second and third each contains 9. Participants were required to find and trace a simple form within a complex figure. Each section is timed and participants proceed through each section simultaneously. A participant is scored based upon how many of the items in section 2 and 3 they answer correctly (maximum score = 18).

Online Embedded Figures Test (OEFT): The OEFT was designed and constructed for this study using a selection of figures originally used by Damarla, Keller, Kana, Cherkassky, Williams, Minshew, and Just (2010). These figures were obtained from the authors (with permission) and adapted to form the OEFT. The OEFT consisted of 47 pairs of simple and complex figures in which participants were asked to decide whether or not the simple figure could be found within the complex figure by answering ‘yes’ or ‘no’. Participants scores are based upon the number of correct responses (maximum score = 47).

Counteracting Mood Manipulation: In order to counteract any negative consequences of the mood manipulation, participants listened to Mozart’s ‘Eine Kleine Nacht Musik’ during the debrief, which has been found in numerous studies to induce happy moods (Avramova & Stapel, 2008; Storbeck & Clore, 2005).

The UoP Health Psychology Online Research Site: The present experiment was hosted on this research site and was used as a platform to present each of the questionnaires and tests to the participants. This online research facility uses a flexible system called SignalBox to manage online and telephone based studies. The site was developed by Dr Ben Whalley at the UoP and was built using ‘Django’ (a high-level python web framework). The site can be accessed using the following link -http://voice.psy.plymouth.ac.uk/

Procedure

Participants were tested in sessions ranging from 1 to 4 people and were visually divided from each other using a screen. Each participant was seated in front of a computer as all tasks (with the exception of the GEFT) were computer based. They were randomly assigned to one of the two conditions (happy vs. sad) using a randomising tool which is part of the SignalBox software. Consequently, the experimenter was blind to which conditions the participants had been assigned to. Previous research has found this to be important in mood manipulation experiments in order to avoid experimenter expectancy effects (Rosenthal, 1994; Sheldrake, 1998). Furthermore, as participants were randomly assigned, it seems reasonable to assume that participant attributes (e.g. IQ, personality type, etc) were randomly distributed amongst conditions. This experiment employed a between subjects design.

Upon signing up for the experiment, participants were informed that the study was investigating individual differences in problem-solving. Firstly, this was so participants were not aware of the mood manipulation as, due to demand characteristics, this may affect the participant's mood and responses (Gillihan, Kessler, & Farah, 2007). Secondly, participants were deliberately not informed that the study was investigating ASD (until the debrief) as this may result in numerous expectations, which may be embellished considering all participants were psychology students. Consequently, it is possible they may conform to demand characteristics and complete the AQ as if they were autistic, or intentionally avoid autistic characteristics due to concerns that they may present with ASD.

After reading a brief (Appendix A) and providing informed consent (Appendix C), participants were required to sign up to the research site in order to participate in the study and submit their data. However, the experimenter did not have access to any personal information used to sign up to the site and all data was analysed anonymously. The first task to be completed was the first PANAS (Appendix D) which asked participants to rate how they were feeling 'RIGHT NOW'. This was aimed to establish a base level of their mood, which was later compared to another PANAS as a means of checking the effectiveness of the mood manipulation. A mood check is often used in studies involving a mood manipulation to ensure participants were successfully induced into the required affective state (e.g. Gemar, Segal, Sagrati, & Kennedy, 2001). Following this PANAS, participants were asked to complete the AQ (Appendix E) to acquire a measure of their autistic traits. The instructions for this task included 'please respond quickly, giving the first answer which comes to mind'. This was to avoid participants from thinking about their response for too long which may influence their answer (Baron-Cohen et al., 2001). The same instruction was also given for each PANAS for the same reason. Depending upon the condition the participant was assigned to (happy vs. sad) participants were then asked to list 10 things that made them either happy or sad (Appendix F). This was aimed to induce them into the required affective state and was followed by another PANAS to access the effectiveness of the mood manipulation. Participants then completed all 47 items of the OEFT (Appendix G). The instructions stated that they should complete the task as 'quickly and accurately as possible' but was not timed. As the OEFT is a newly designed adaption of the EFT, a standardised version of the EFT was administered afterwards to ensure the OEFT was a valid and reliable measure of local vs. global processing and subsequently, WCC. As this task was not computer-based, once participants had finished the OEFT, an instruction appeared upon their screen informing them that the next task needed to be completed simultaneously with the other participants and that they should quietly inform the experimenter they have finished and await further instructions.

The final task for the participants was the standardised GEFT (Appendix H) which needed to be completed at the same time as the other participants as it involves timing each section of the test booklet. The standard instructions for administering the GEFT which are set out in the testing manual were adhered to. The entire GEFT took approximately 15 minutes to administer. Once all participants had completed this task, they were given a verbal and written debrief (Appendix I). During this debrief, Mozart's Eine Kleine Nacht Musik was played in the background in order to counteract any negative effects of the mood manipulation. The debrief explained the true nature of the study and also emphasised that the AQ is not a diagnostic tool and even a high score is not necessarily indicative of ASD. They were also given details of the University's counselling service in case they were affected by any of the issues raised during the study. Participants were then given an opportunity to ask any questions that they may have and were reminded of their right to withdraw their data. Experiment 1 in its entirety took no longer than 30 minutes to complete for each participant and after completion they were granted course credit for taking part.

The results were analysed using a variety of statistical methodologies. To establish whether the mood manipulation was successful, a *paired* t-test was used to determine whether there was a significant difference between the before and after PANAS scores, for each condition. The results from the OEFT were correlated against scores from the GEFT to determine the construct validity of the OEFT. Furthermore, the scales internal reliability was ascertained using an inter-item analysis using Cronbach's Alpha. Finally, the various relationships between AQ scores, PANAS scores, OEFT scores and gender differences were analysed using multiple regression models and correlational analysis.

Experiment 2

Experiment 2 was an online longitudinal study which took place over the period of four weeks. This experiment investigated the natural fluctuations in a participant's mood and examined this with regards to autistic traits and performance on the OEFT. Participant's results from the GEFT and OEFT in Experiment 1 were used to assess the validity of the OEFT which was used exclusively in this experiment. Participant's results were analysed on the basis of both a between-subjects and within-subjects design.

Participants

Seventy undergraduate psychology students (8 males, 56 females, 6 gender unspecified) from the UoP participated in Experiment 2. Participants were between the ages of 19 and 51 years (mean age = 20.4, SD = 5.77) and those with a history of mental health difficulties were excluded from the study. No other biographical data was recorded. Participants were recruited using the Plymouth Psychology Participation Pool and received course credit for taking part. One aspect of the analysis involved dividing participants according to measures of autistic traits into a high AQ group and a low AQ group which was based upon their scores on the AQ. This was achieved using the same cut off criteria as Baylis and Kritikos (2010) in which participants with scores of greater than or equal to 15 (average AQ score) were placed in the high AQ group (mean AQ=19.75, n=36) and those with scores below were placed into the low AQ group (mean AQ=10.79, n=28). All participants provided informed consent before participating.

Materials

The PANAS, AQ, OEFT and the UoP Health Psychology Online Research site from Experiment 1 were also used in Experiment 2. However, the OEFT was divided into 4 sets, in which the first set had 11 items and the other 3 had 12 items, to be completed at each weekly interval. Therefore, during the within-subjects analysis, the maximum OEFT score for each trial was either 11 or 12. However, during the between-subjects analysis, the score for each trial of the OEFT was combined to produce a participants total OEFT score (maximum score = 47).

Procedure

Upon signing up for the experiment, participants were informed that the study was investigating individual differences in problem-solving. This was for the same reasons specified in Experiment 1. As this study was online and participants were unmonitored during completion, they were informed that it is important that they complete the study on their own. Once participants had signed up to the study via the Plymouth Psychology Participation Pool, they were given a link directing them to the UoP Health Psychology Online Research site. On this site, participants read a brief (Appendix B) and had their rights explained to them before providing informed consent by clicking ‘I agree to these conditions’ (Appendix C). They were then asked to sign up to the site in order to take part in the study. This experiment consisted of four parts which each took place a week apart, employing an ‘experience sampling’ technique (i.e. data was recorded at temporal intervals whilst participants were involved in their respective routines; Schimmack, 2003)

The first task participants completed was the AQ (Appendix E) followed by the PANAS (Appendix D). They were then asked to complete 11 items of the OEFT (Appendix G). The instructions for all of these tasks were the same as in Experiment 1. Once the OEFT was complete, participants were informed that they will receive an email in one week for the next part of the experiment. The UoP Health Psychology Online Research site is able to automatically email participants with the next part of the study. As this system is automated, the experimenter was not aware of the participants email address or name when analysing results. One week after signing up, participants received an email containing a link to the second part of the study. This involved them completing a PANAS and another 12 items of the OEFT. Participants continued to receive an email and complete the PANAS and OEFT for the third and fourth instalment of the study, each trial taking place one week apart. The reason for completing the PANAS at weekly intervals was to capture the natural variations in people’s mood and then examining these with regards to autistic traits and OEFT performance. Previous research has suggested that individual’s moods fluctuate on a daily basis and to capture these varying states, inter-temporal recording is often used (Mehra & Sah, 2002). In the final part of the study, after completing the OEFT, participants were directed to a debrief (Appendix I), which was the same written debrief given to participants in Experiment 1. Participants were awarded course credit for taking part and collectively, the study took no longer than 30 minutes of each participant’s time.

Analysis for Experiment 2 was divided into between-subjects and within-subject effects. During the between-subjects analysis, the various relationships between AQ scores, PANAS scores and OEFT scores were analysed using multiple regression models and correlational analysis. Furthermore, additional analysis was carried out using the high and low AQ groups to divide participants according to level of autistic traits. The significance of any differences between the groups was established using an independent *t*-test. As gender was not evenly distributed in Experiment 2, gender differences were not investigated. The within-subjects analysis involved using a fixed-effects model with dummy variables. Although using this technique for large groups can reduce the reliability of the coefficients, as these were not the primary focus of this study, this was not seen as disadvantageous. Multiple regressions and correlations between variables were investigated which aimed to take into consideration the fluctuations in each participants mood and OEFT scores throughout each of the four trials.

Results

Validity and Reliability of the OEFT

The OEFT was developed for this study to provide an accurate and reliable measure of participant's performance on the embedded figures task and thus provide a measure of WCC. Both Experiment 1 and Experiment 2 were used to establish the validity and reliability of this scale. To determine the construct validity of the OEFT, each participant completed the standardised GEFT in addition to the OEFT during Experiment 1. Pearson correlation coefficients were calculated in which a significant positive correlation was found between participants OEFT and GEFT scores ($r = .508$, $N = 56$, $p < .05$, one-tailed). The internal consistency of the OEFT was established using item analysis, resulting in a Cronbach's Alpha of .819. The scales reliability was examined further during Experiment 2, in which scores from each of the four subsets of the OEFT were found to significantly correlate with each other, across each trial (results shown in Table I). Collectively, these tests of reliability and validity suggest that the OEFT is a suitable variation of the embedded figures test and is therefore, an acceptable measure of weak central coherence.

Table I: Correlations between each OEFT subset from Experiment 2.

Variable	OEFT Subset 1	OEFT Subset 2	OEFT Subset 3	OEFT Subset 4
OEFT Subset 1	-	.473**	.532**	.601**
OEFT Subset 2	.473**	-	.563**	.759**
OEFT Subset 3	.532**	.563**	-	.668**
OEFT Subset 4	.601**	.759**	.688**	-

Note. ** $p < .01$

Experiment 1

Descriptive statistics showing results from the AQ, PANAS, OEFT and GEFT is shown in Table 2 for all participants and each experimental condition.

Table 2: Group Means and Standard Deviations for all participants and the two experimental conditions for measures of autistic traits (AQ), affect (PANAS) and WCC (OEFT & GEFT).

	All Participants (n=56)			Sad Condition (n=26)			Happy Condition (n=30)		
Variable	**Range**	***M***	***SD***	**Range**	***M***	***SD***	**Range**	***M***	***SD***
AQ Total Score	5-27	14.95	4.50	0-24	13.22	4.71	0-27	15.48	5.46
Attention to Detail	0-10	4.79	2.39	0-8	4.19	2.34	0-10	5	2.63
Social Skills	0-8	1.52	1.68	0-3	1.11	0.97	0-8	1.77	2.08
Imagination	0-6	1.95	1.63	0-4	1.56	1.15	0-6	2.16	1.95
Communication	0-7	1.77	1.51	0-5	1.52	1.19	0-7	1.87	1.77
Attention Switching	1-9	4.52	1.75	0-8	4.44	1.99	0-9	4.29	1.87
PANAS Negative (before)	10-32	14.38	5.55	10-27	14.54	5.35	10-32	14.23	5.80
PANAS Negative (After)	10-33	13.79	5.49	10-31	14.92	5.89	10-33	12.80	5.01
PANAS Positive (Before)	13-46	29.91	6.94	16-46	29.50	7.53	13-40	30.27	6.50
PANAS Positive (After)	15-44	29.43	7.46	19-44	28.58	7.57	15-43	30.17	7.40
OEFT Total Score	21-47	34.13	6.53	24-44	34.85	5.84	21-47	33.50	7.12
GEFT Total Score	2-18	12.64	4.16	2-18	12.08	4.72	7-18	13.13	3.61

Table 2 shows that participants in Experiment 1 had a mean AQ total score of 14.95, which is similar to the original average scores for non-clinical samples found by Baron-Cohen et al. (2001). Furthermore, the mean GEFT score (mean = 12.64) was also consistent with the suggested average score by Oltman et al. (1971).

Participants in the happy condition seemed to report the highest AQ scores (mean = 15.48), GEFT scores (mean = 13.13) and reported lower negative affect on the PANAS presented after the mood manipulation (mean = 12.80). Participants in the sad condition reported higher OEFT scores (mean = 34.85). However, the significance of these results is dependent upon the effectiveness of the mood manipulation in producing each experimental group.

Mood Manipulation Check

A paired *t*-test was used to measure the extent that PANAS scores differed both before and after the mood manipulation. No significant differences were found between the negative PANAS scores in the sad condition, $t(25) = -.415$, $p>.05$, one-tailed, or the positive PANAS scores in the happy condition, $t(29) = .125$, $p>.05$, one-tailed. However, there was a significant decline in negative affect for participants in the happy condition, $t(29) = 2.90$, $p < .05$, one-tailed, suggesting they were in a more positive mood. Therefore, although the mood manipulation for the happy condition seemed partly successful, it did not seem to impact upon scores of negative affect in the sad condition. Therefore, the mood manipulation did not seem to be effective in inducing participants into the two desired affective states. With this in mind, results from Experiment 1 relating to mood, are not considered reliable. Further analysis was nevertheless conducted. The PANAS participants completed after the mood manipulation was used for all analysis relating to affect.

Autistic Traits and Weak Central Coherence

A multiple regression using the enter method was performed on all subscales of the AQ and OEFT scores. Scores from the AQ subscales were not found to be a significant predictor of OEFT performance: $F(6, 49) = 1.198$, $p >.05$. However, the 'Attention to detail' subscale of the AQ was approaching a significant positive correlation with OEFT performance ($r = .219$, $N = 56$, $p = .052$, one tailed). Further analysis using the GEFT did not find AQ Scores to be a significant predictor of GEFT performance: $F(6, 49) = .745$, $p > .05$. Therefore, no correlation was found between autistic traits and WCC, which is contrary to the present study's prediction.

Further analysis of gender differences was investigated, although no relevant significant results were found. However, female participants scores for the 'attention to detail' subscale were approaching significance ($r = .258$, $N = 34$, $p = .071$).

Affect and Weak Central Coherence

PANAS scores for negative affect did not significantly correlate with OEFT performance ($r = -.101$, $N = 56$, $p > .05$, one-tailed). Furthermore, PANAS scores for positive affect did not correlate with OEFT scores ($r = .131$, $N = 56$, $p > .05$, one-tailed). The PANAS scores for positive affect displayed a positive correlation with GEFT scores ($r = .284$, $N = 56$, $p < .05$, one-tailed), whereas negative affect was approaching a significant negative correlation with the GEFT ($r = -.211$, $N = 56$, $p = .060$, one-tailed). These results suggest that participants reporting higher positive affect and less negative affect scored higher on the GEFT, which is not consistent with the study's prediction.

Autistic Traits and Affect

No significant correlation was found between PANAS scores for negative affect and overall AQ scores (r = -.016, $N = 56$, $p > .05$, one-tailed). In addition, a multiple regression using the enter method did not find any of the AQ subscales to significantly predict negative affect: F (5, 50) = .271, $p > .05$. Similarly, overall AQ scores did not correlate with positive affect, although the results were approaching a significant positive correlation (r = .204, $N = 56$, $p = .066$, one-tailed). A positive correlation was found between the AQ subscale ‘attention to detail’ and positive affect (r = .325, $N = 56$, $p < .05$, one-tailed). Finally, a multiple regression did not find AQ subscales to significantly predict positive affect: F (5, 50) = 1.287, $p > .05$. These findings suggest that participants with higher autistic traits, did not report more negative affect, which is against this study’s predictions.

Autistic Traits, Affect and Weak Central Coherence

In the sad condition, a multiple regression using the enter method with AQ subscales as predictor variables did not significantly predict OEFT performance: F (5, 20) = .549, $p > .05$. Overall AQ scores did not correlate with OEFT performance (r = -.188, $N = 26$, $p > .05$, one-tailed). Also, a multiple regression model using AQ subscales to predict GEFT performance, did not produce a significant model: F (5, 20) = .665, $p > .05$. No correlation was found between overall AQ score and GEFT scores (r = .137, $N = 26$, $p > .05$, one-tailed). Consequently, no significant correlation was found between AQ scores and WCC for participants in the sad condition, which is against this study’s main prediction.

In the happy condition, a multiple regression using the enter method did not find the AQ subscales to significantly predict OEFT performance: F (5, 24) = 1.572, $p >.05$). Overall AQ scores were approaching a significant correlation with OEFT scores (r = .268, $N = 30$, $p = .076$, one-tailed) and a significant positive correlation was found between the ‘attention to detail’ subscale and OEFT scores (r = .424, $N = 30$, $p < .05$, one-tailed). Using the GEFT, a multiple regression did not find the AQ subscales to significantly predict GEFT performance: F (5, 24) = .891, $p > .05$. A significant correlation was not found between overall AQ scores and GEFT scores (r = .055, $N = 30$, $p > .05$, one-tailed). These findings suggest that positive affect seemed to be predicting WCC, as the results were approaching significance, which is contrary to Experiment 1’s main prediction.

A multiple regression with the enter method using overall AQ scores and PANAS scores for negative affect as predictor variables for OEFT performance, did not produce a significant model: F (2, 53) = .390, $p > .05$. Furthermore, when overall AQ scores and negative affect scores were used as predictor variables for GEFT performance, a significant regression model was still not produced: F (2, 53) = 1.757, $p > .05$. Consequently, negative affect and AQ scores did not seem to significantly predict WCC, which is not consistent with Experiment 1’s hypothesis.

Due to the ineffectiveness of the mood manipulation, the results from Experiment 1 are not considered to be an accurate representation of the interactions between autistic traits, affect and WCC. With this in mind, although analysis of gender differences was conducted, the results were not reported as they were considered unreliable.

Experiment 2

Experiment 2 experienced substantial participant drop out and in particular, many participants failed to complete each part of the study. Consequently, although the study recruited 70 different participants, many did not complete all four parts of the study. The results in Table III display the completion rates for each week's tasks. Table 3 shows that after initially signing up to the study in week 1, completion rates begin to decline.

Table 3: Number of participants completing each trial of Experiment 2

	Participants	AQ	PANAS & OEFT Week 1	PANAS & OEFT Week 2	PANAS & OEFT Week 3	PANAS & OEFT Week 4
n =	70	64	64	54	50	50

The analysis for experiment 2 has been divided into examining between-subjects and within-subjects effects.

Between-Subjects Analysis

For the between-subjects analysis, OEFT scores from all 4 trials were combined to produce an overall OEFT score (maximum score = 47). Furthermore, PANAS scores for negative and positive affect were averaged for each participant. Descriptive statistics for the between-subjects analysis for the AQ, PANAS and OEFT are shown in Table 4.

Table 4: Group Means and Standard Deviations for all participants displaying measures of autistic traits (AQ), affect (PANAS) and WCC (OEFT).

		All Participants (n=70)	
Variable	**Range**	***M***	***SD***
AQ Total Score	5-30	15.83	11.63
Attention to Detail	0-10	5.00	2.05
Social Skills	0-6	1.63	1.66
Imagination	0-8	1.88	1.74
Communication	0-8	2.06	1.57
Attention Switching	1-9	4.70	1.93
PANAS Negative (Average)	10-38	15.97	6.16
PANAS Positive (Average)	12-44	25.19	6.08
OEFT Total Score	4-46	24.47	11.63

Table 4 shows that the average AQ score (mean = 15.83) is consistent with the original average scores for non-clinical samples found by Baron-Cohen et al. (2001). The average total score for the OEFT (mean = 24.47) is considerably lower compared to Experiment 1 (mean = 34.13). However, this can be explained as being a result of most participants not completing each trial of the OEFT in Experiment 2, resulting in the summed score across 4 trials being lower (see Table 3).

Autistic Traits and Weak Central Coherence

No significant correlation was found between overall AQ scores and OEFT performance (r = .160, N = 64, p > .05, one-tailed). A multiple regression using the enter method was ran using the AQ subscales as predictor variables for OEFT performance, but did not produce a significant model: F (5, 58) = 1.680, p > .05.

Significant results were found between some AQ subscales and OEFT results, but these were not of great consequence. Upon comparison of the mean OEFT scores from participants in the high and low AQ group, the high AQ group seemed to score higher (mean = 26.67, SD = 11.01) than the low AQ group (mean = 22.82, SD = 12.56). However, an independent *t*-test did not find the difference to be significant, $t(62) = -1.303$, $p > .05$, one-tailed. A multiple regression using results from AQ subscales from the high AQ group did not find a significant model predicting OEFT performance: F (5, 30) = .873, $p > .05$. Therefore, no relationship was found between autistic traits and WCC, which is contrary to this study's predictions.

Autistic Traits and Affect

A significant correlation was found between overall AQ scores and PANAS scores for negative affect (r = .290, N = 64, $p < .05$, one-tailed). A scatterplot showing this correlation is shown in Figure I., in which a linear fit line has been inserted to highlight the positive correlation. A multiple regression with the enter method did not produce a significant model, using AQ subscales to predict negative affect: F (5, 58) = 1.670, $p > .05$.

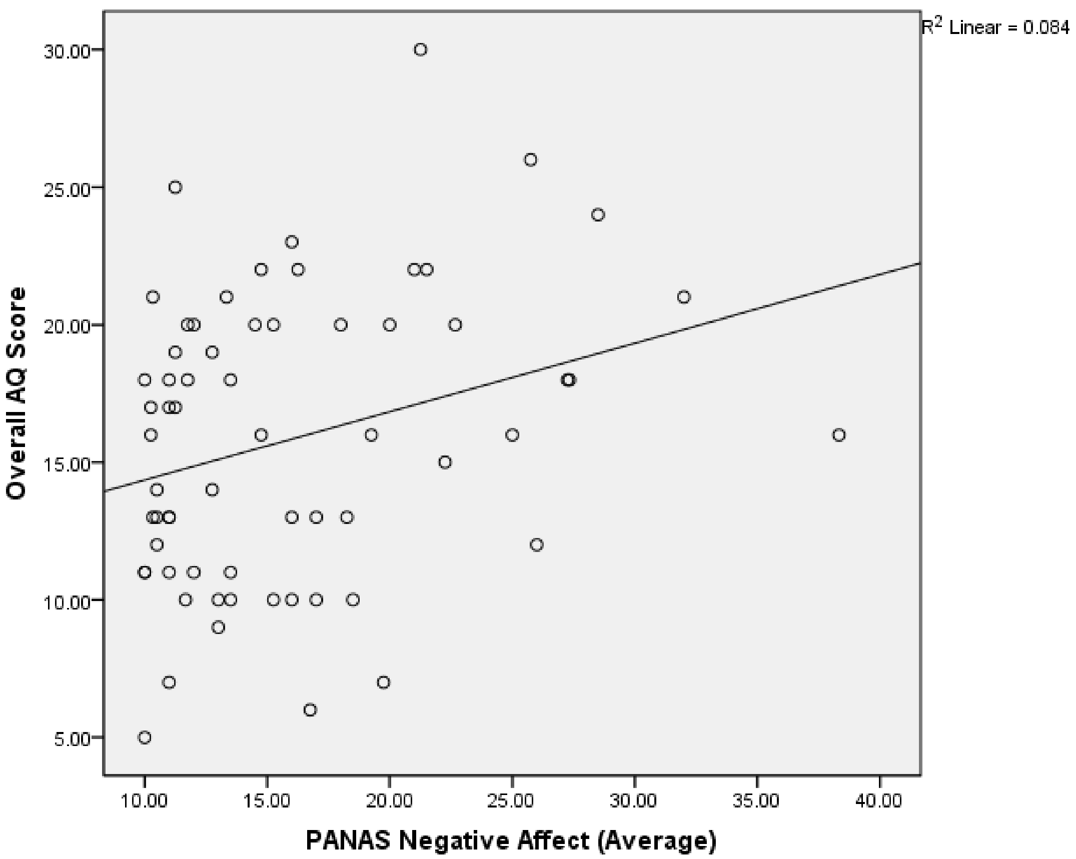

Figure I: Scatterplot displaying overall AQ scores and average PANAS negative affect scores

Participants who were in the high AQ group reported more negative affect (mean = 17.59, SD = 7.14) compared to the low AQ group (mean = 13.78, SD = 3.83). An independent *t*-test showed that reports of negative affect between the high and low

AQ group differed significantly, $t(55.83) = -2.739$, $p = < .05$, one-tailed (equality of variance was not assumed, $p < .05$).

This significant difference can be clearly seen in a bar graph in Figure 2. Therefore, consistent with predictions, participants possessing more autistic traits seem to report higher levels of negative affect.

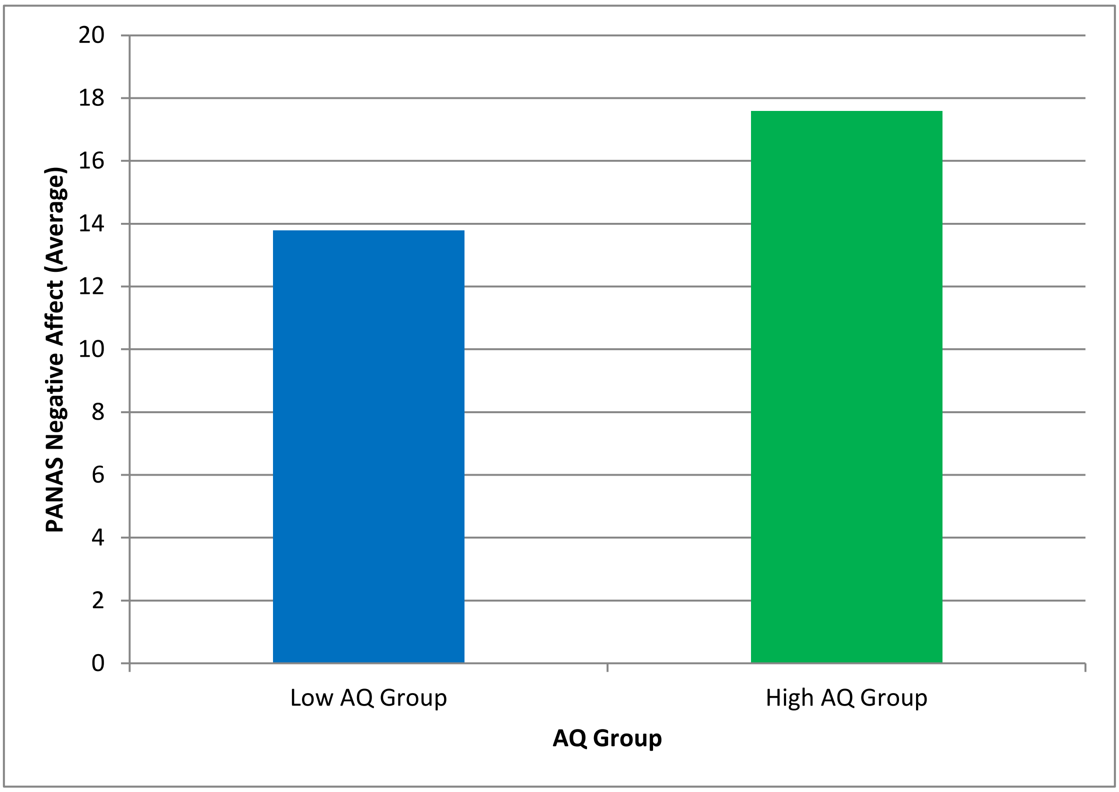

Figure 2: Mean PANAS scores of negative affect for the high and low AQ groups.

A multiple regression with the enter method using scores from participants in the high AQ group did not produce a significant model using AQ subscales as predictor variables for negative affect: F (5, 30) = .562, $p > .05$. No significant correlation was found between overall AQ scores and PANAS scores for positive affect (r = -.157, N = 64, $p > .05$, one-tailed). A multiple regression using the enter method, did not produce a significant model for AQ subscales predicting positive affect: F (5, 58) = .756, $p > .05$. Furthermore, a multiple regression using results from the high AQ group did not produce a significant model using AQ subscales as predictor variables for positive affect: F (5, 30) = .417, $p > .05$.

Affect and Weak Central Coherence

A significant negative correlation was found between positive affect and OEFT scores (r = -.367, N = 70, $p < .05$, one-tailed). Therefore, participants reporting less positive affect seemed to perform better at the OEFT, which is consistent with the present study's predictions. However, no significant correlation was found between negative affect and OEFT performance (r = .146, N = 70, $p > .05$, one-tailed). A multiple regression using the enter method produced a significant regression model using PANAS scores as predictor variables for OEFT performance: F (2, 67) = 5.799, *p* < .05. This model accounted for 12.2% of the variance (Adjusted R^2 = .122). Table 5 gives information for the predictor variables entered into the model. This table shows that positive affect is a significant predictor of OEFT performance.

Table 5: Unstandardised and Standardised regression coefficients for PANAS scores predicting OEFT performance.

Variable	B	SE B	□
PANAS Negative Affect	.215	.214	.114
PANAS Positive Affect	-.683	.217	-.357*

*Note. *p* < .01.

Autistic Traits, Affect and Weak Central Coherence

A significant negative correlation was found for participants in the high AQ group, between PANAS scores of positive affect and OEFT performance (r = -.544, *N* = 36, *p* < .05, one-tailed). This finding suggests that participants possessing high autistic traits who display less positive affect, show enhanced OEFT performance, indicative of WCC. This result is consistent with the predictions for Experiment 2. Figure 3 shows a scatterplot of reports of positive affect and OEFT performance for both the high and low AQ groups. The scatterplot clearly shows the negative correlation between positive affect and OEFT scores for only the high AQ group.

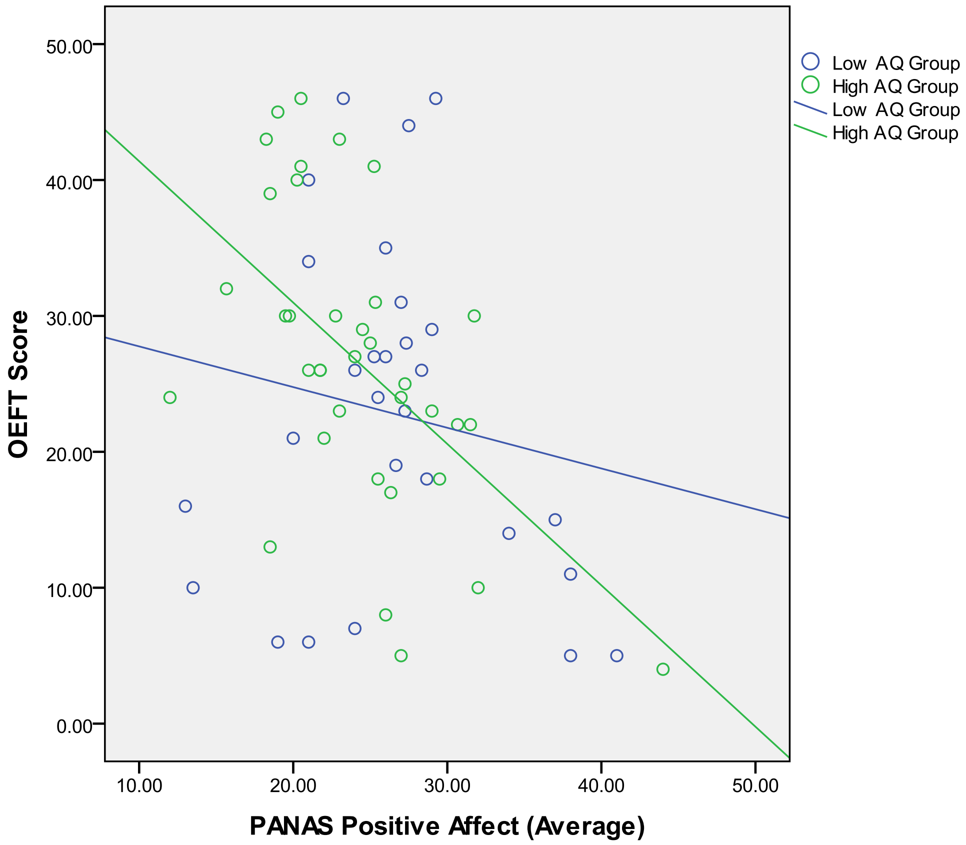

Figure 3: Scatterplot displaying mean PANAS scores for positive affect and OEFT scores for the high and low AQ group.

A multiple regression (using the enter method) between PANAS scores and OEFT performance for the high AQ group, produced a significant model: *F* (2, 33) = 7.181, *p* < .05. The model explains 26.1% of the variance (Adjusted R^2 = .261). Table 6 gives information for the predictor variables entered into the model, which shows that positive affect was a significant predictor of OEFT performance for participants in the high AQ group.

Table 6: Unstandardised and Standardised regression coefficients for PANAS scores predicting OEFT performance for the high AQ group.

Variable	**B**	**SE B**	□
PANAS Negative Affect	-.135	.225	-.087
PANAS Positive Affect	-1.050	.278	-.549*

Note. **p* < .01

Results from the low AQ group found a significant correlation between PANAS scores for negative affect and OEFT scores (r = .451, *N* = 28, *p* < .05, one-tailed). This finding suggests that participants with fewer autistic traits reporting higher negative affect, performed better at the OEFT, which is contrary to the previous finding and this study's predictions. Figure 4 shows a scatterplot of both the high and low AQ group's reports of negative affect and OEFT performance. The scatterplot clearly shows the positive correlation between negative affect and OEFT scores for the low AQ group.

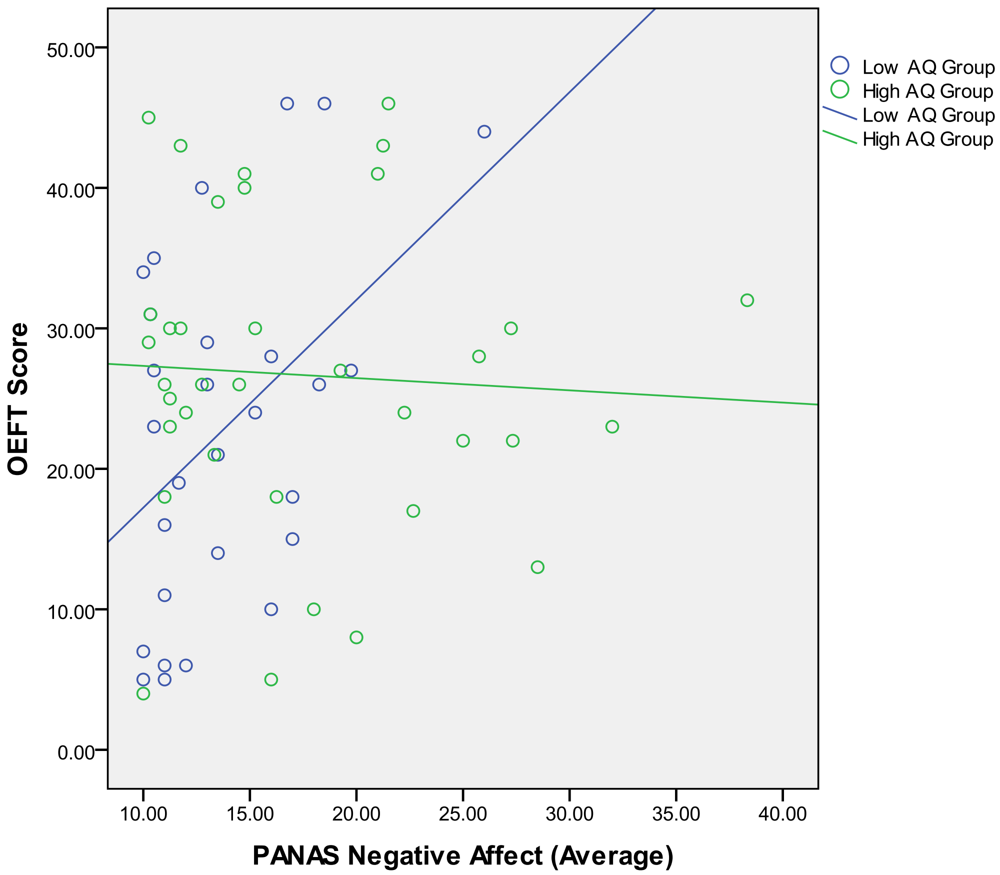

Figure 4: Scatterplot displaying mean PANAS scores for negative affect and OEFT scores for the high and low AQ group.

A multiple regression using the enter method between PANAS scores and OEFT performance for the low AQ group did produced a significant model: *F* (2, 25) = 3.714, $p < .05$. This model explains 16.7% of the variance (Adjusted $R^2 = .167$). Table 7 gives information for the predictor variables entered into the model, which shows that negative affect was a significant predictor of OEFT performance for participants in the low AQ group.

Table 7: Unstandardised and Standardised regression coefficients for PANAS scores predicting OEFT performance for the low AQ group.

Variable	**B**	**SE B**	**β**
PANAS Negative Affect	1.477	.576	.451*
PANAS Positive Affect	-.296	.327	-.159

Note. *$p < .05$.

A multiple regression with the enter method was also performed using overall AQ scores and PANAS scores for negative affect as predictor variables for OEFT performance, however, a significant model was not produced: *F* (2, 61) = 1.143, $p > .05$. When overall AQ scores and positive affect were used as predictor variables for OEFT performance, a significant model was produced: *F* (2, 61) = 5.246, $p < .05$. This model was able to explain 11.9% of the variance (Adjusted $R^2 = .119$). Table 8 gives information for the predictor variables entered into the model, which shows that positive affect was a significant predictor of OEFT performance. This model suggests that AQ scores and low reports of negative affect seem to predict OEFT performance, which is consistent with this study's predictions.

Table 8: Unstandardised and Standardised regression coefficients for PANAS positive affect and AQ scores predicting OEFT performance.

Variable	**B**	**SE B**	**β**
PANAS Negative Affect	.232	.266	.105
PANAS Positive Affect	-.662	.225	-.352*

Note. *$p < .01$.

Within-Subjects Analysis

In order to analyse participants varying scores on the PANAS and OEFT between each week, a within-subjects analysis was conducted. Therefore, OEFT scores are now analysed on the basis of each individual trial, which has a maximum score of either 11 or 12. This was achieved using a fixed effects model with dummy variables. Although using this technique for large groups can reduce the reliability of the coefficients, as these were not the primary focus of this study, this was not seen as disadvantageous. Descriptive statistics for each trial (week) of Experiment 2 are shown in Table 9. Reports of AQ scores can be found in Table 4. Table 9 shows that average OEFT scores for the 12 item trials (weeks 2, 3 & 4) are very similar (approx. 8) which is a good indicator of reliability. Furthermore, the variation in the range of PANAS scores obtained between each week, suggests that participants ratings of mood did indeed fluctuate which is advantageous for analysing the influence of different affective states.

Table 9: Group Means and Standard Deviations for each trial displaying measures of affect (PANAS) and WCC (OEFT).

	Week 1 (n=64)			**Week 2 (n=54)**			**Week 3 (n=50)**			**Week 4 (n=50)**		
Variable	**Range**	**Mean**	**SD**	**Range**	**Mean**	**SD**	**Range**	**Mean**	**SD**	**Range**	**Mean**	**SD**
OEFT Scores	2-11	6.73	2.32	5-12	8.72	1.99	2-12	8.18	2.41	3-12	8.09	2.73
PANAS Negative	10-41	15.84	7.08	10-37	16.19	7.36	10-34	16.96	7.27	10-44	16.06	7.96
PANAS Positive	11-45	26.29	8.26	11-41	24.51	7.24	10-40	23.44	7.27	10-43	23.42	7.41

Note. Maximum OEFT score for week 1 is 11, week 2, 3 and 4 is 12.

Autistic Traits and Weak Central Coherence

No significant correlation was found between overall AQ scores and OEFT performance (r = .018, N = 64, p > .05, one-tailed). A significant positive correlation was found between the AQ ‘attention to detail’ subscale and OEFT performance, although the effect was weak (r = .164, N = 64, p < .05). Even so, conclusive evidence of WCC was not found, which is contrary to this study’s predictions.

Autistic Traits and Affect

A significant weak correlation was found between overall AQ scores and PANAS scores of negative affect (r = .189, N = 64, p < .05, one-tailed). Furthermore, a significant weak negative correlation was found between overall AQ scores and positive affect (r = -.122, N = 64, p < .05, one-tailed). These findings are consistent with this study’s predictions, in which individuals with higher autistic traits seem to report more negative affect, and less positive affect. However, these effects were weak.

Affect and Weak Central Coherence

A significant weak negative correlation was found between PANAS scores for positive affect and OEFT scores (r = -.177, N = 70, p < .05, one-tailed). This result suggests that individuals reporting less positive affect score higher on the OEFT, which is consistent with this study’s predictions. However, no significant results were found for negative affect.

Autistic Traits, Affect and Weak Central Coherence

For the high AQ group, a significant negative correlation was found between PANAS scores of positive affect and OEFT performance (r = -.338, N = 36, p < .05, one-tailed). Figure 5 shows a scatterplot of negative affect scores and OEFT performance for both the high and low AQ group. The scatterplot shows that individuals in the high AQ group reporting less positive affect, performed better at the OEFT, which is consistent with the study’s prediction.

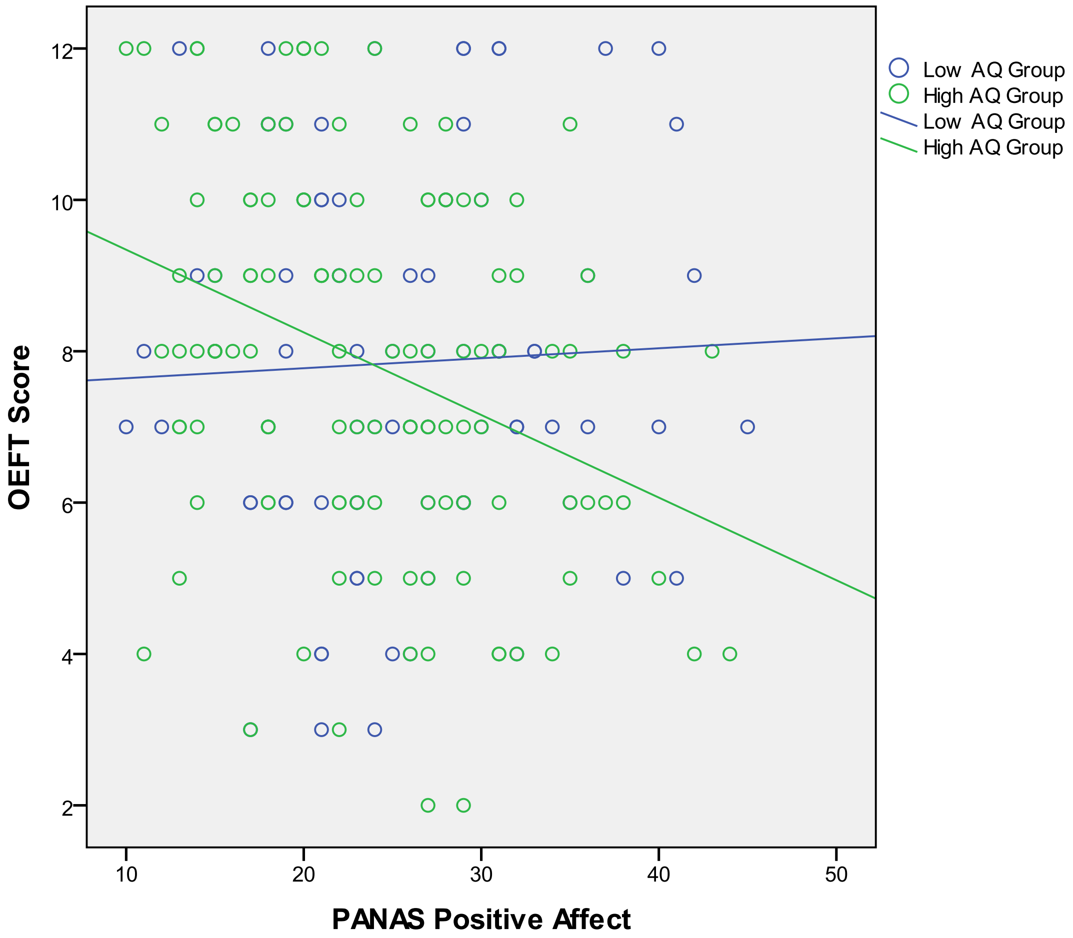

Figure 5: Scatterplot displaying mean PANAS scores for positive affect and OEFT scores for the high and low AQ group

A multiple regression using the enter method with dummy variables produced a significant model between PANAS scores and OEFT performance for the high AQ group: F (37, 81) = 4.495, p < .05. This model was able to explain 52.3% of the variance (Adjusted R^2 = .523). Table 10 gives information for the predictor variables entered into the model, which shows that positive affect was a significant predictor of OEFT performance.

Table 10: Unstandardised and Standardised regression coefficients for PANAS scores predicting OEFT performance for the high AQ group.

Variable	**B**	**SE B**	□
PANAS Negative Affect	.021	.039	.066
PANAS Positive Affect	-.053	.026	-.164

Note. *p < .05.

Analysis of scores from the low AQ group found a significant positive weak correlation between PANAS scores of negative affect and OEFT scores (r = .199, N = 28, p < .05, one-tailed). Figure 6 shows that individuals in the low AQ group reporting higher negative affect scored higher on the OEFT, which is contrary to this study's predictions.

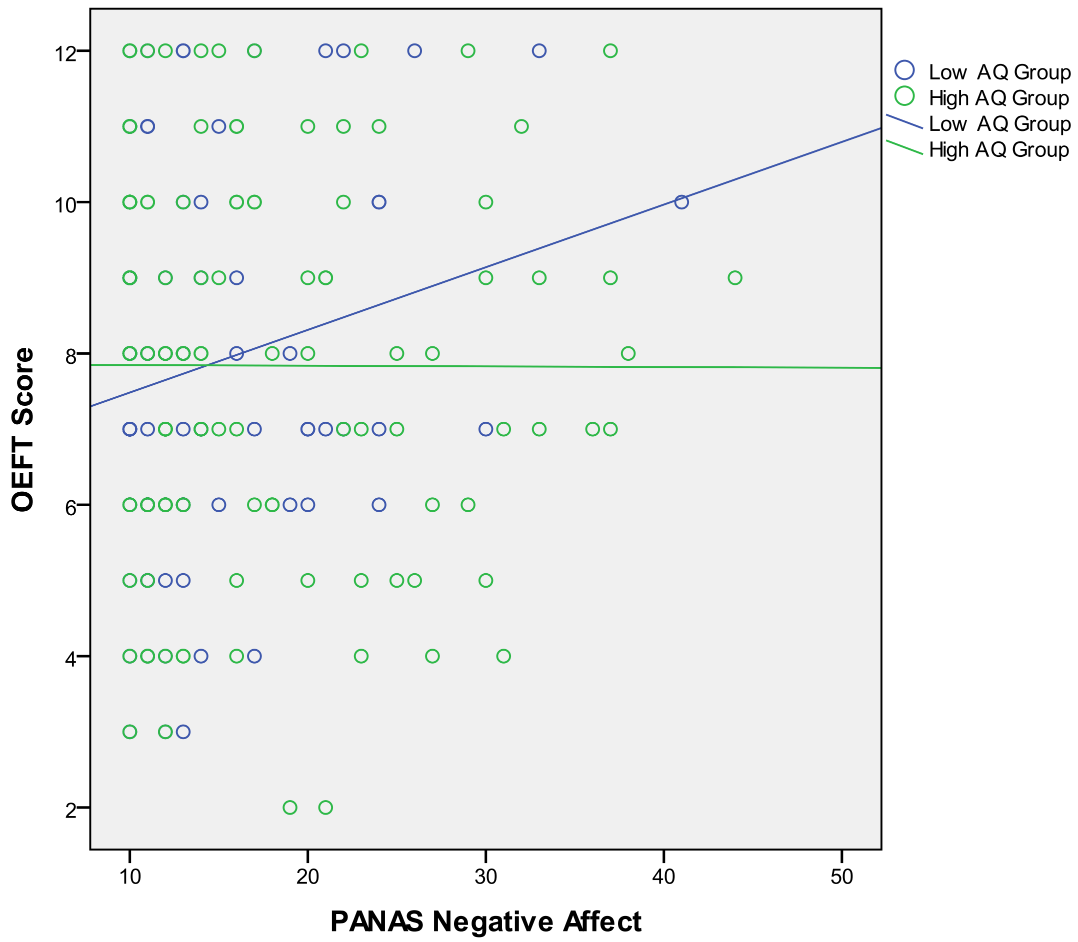

Figure 6: Scatterplot displaying mean PANAS scores for positive affect and OEFT scores for the high and low AQ group

A multiple regression using the enter method with dummy variables produced a significant model between PANAS scores and OEFT performance for the low AQ group: F (28, 51) = 3.924, p < .05. This model was able to explain 50.9% of the variance (Adjusted R^2 = .509). Table 11 gives information for the predictor variables entered into the model, which shows that neither negative or positive affect was a significant predictor of OEFT performance.

Table 11: Unstandardised and Standardised regression coefficients for PANAS scores predicting OEFT performance for the low AQ group.

Variable	**B**	**SE B**	□
PANAS Negative Affect	.017	.045	.041
PANAS Positive Affect	.014	.033	.045

Note. *p < .05.

General Discussion

The present study aimed to determine the potential influence of negative affect in WCC (assessed by enhanced EFT performance) for individuals with high autistic traits. However, support for this hypothesis is inconclusive based upon the results from this study. Experiment 1 did not find support for this hypothesis, in which participants AQ scores did not predict OEFT performance in the sad condition. Furthermore, contrary to predictions, a correlation between AQ scores and OEFT performance was approaching significance in the happy condition. In Experiment 2, some support for this hypothesis was found in which participants in the high AQ group reporting less positive affect, showed better OEFT performance. However in contrast, a correlation was found between higher negative affect and OEFT performance for participants in the low AQ group. Furthermore, neither experiment found conclusive evidence for the WCC hypothesis in which participants with higher autistic traits did not seem to show enhanced detail-based processing. As predicted, Experiment 2 did find some evidence that people reporting higher autistic traits also reported more negative affect. Experiment 2 also supported the prediction that participants reporting less positive affect would perform significantly better at the OEFT. Experiment 1 did not find support for either of these predictions, in which positive affect was found to significantly predict EFT performance.

The contrary findings in Experiment 1 are not entirely unexpected considering the mood manipulation was not successful in inducing participants into the required affective states. The participants in the sad condition showed no significant difference in negative or positive affect after the mood manipulation. However, those in the happy condition did report a significant decline in negative affect, suggesting they were in a more positive mood. Furthermore, after the experiment, numerous participants spontaneously mentioned to the experimenter that they ‘enjoyed’ completing both the OEFT and GEFT. This could help explain some of the adverse findings in Experiment 1. Individuals who engage in a task out of interest or enjoyment are driven by ‘intrinsic motivation’, whereas those completing a task for a separable outcome (e.g. course credit) are using ‘extrinsic motivation’ (Mizuno, Tanaka, Fukuda, Imai-Matsumura, & Watanabe, 2011). Research has also found that positive affect can increase people’s enjoyment and interest of a task and this can in turn increase their intrinsic motivation (Isen & Reeve, 2005). This is relevant as field independent individuals (a cognitive style indicative of a high EFT score) have been found to exhibit higher achievement and perform more effectively on tasks under conditions of intrinsic motivation (Bolocofsky, 1980; Goodenough, 1976; Rittschof, 2010). This could explain why participants in the happy condition (reporting less negative affect) who enjoyed the task, performed better on the OEFT than those in the other condition whose mood was unchanged. Had the mood manipulation been successful in inducing participants into a negative state, it seems likely that detail-based processing associated with negative affect would have resulted in even higher performance than the happy condition. Consequently, participants did not exhibit sufficient negative affect to contrast against the intrinsically motivated participants in the happy condition. Furthermore, research has found that high ‘approach motivation’ (motivation related to goal-directed behaviour) and positive affect can actually narrow attention, making it less likely for individuals to adopt a global attentional focus (Gable & Harmon-Jones, 2008). Collectively, these motivation-based explanations may elucidate why Experiment 1 found positive affect to predict GEFT performance and a why correlation between AQ scores and OEFT performance was approaching significance in the happy condition. Further research controlling for motivational factors may shed light upon its effect on detail-based processing tasks in relation to the WCC hypothesis.

This study did not find evidence of WCC in participants with high levels of autistic traits. Experiment 1 did not find any relationship between autistic traits and detail-based processing, which was also the case for the between-subjects analysis in Experiment 2.This is consistent with previous research by Kunihira et al. (2006) who also used the AQ to measure autistic traits, but did not find any relationship between AQ scores and cognitive abilities, such as WCC, ToM and executive function. However, this study did report higher AQ means from their sample (Japanese students) compared to those originally reported by Baron-Cohen et al. (2001) using a British sample (Grinter et al., 2009). Burnette et al. (2005) also failed to find support for the WCC hypothesis, in which children with ASD did not demonstrate a local preference on measures of WCC. However, this study was limited by methodological issues (as previously mentioned). Experiment 2 did find some evidence for WCC during the within-subjects analysis, in which a significant weak correlation was found between the AQ ‘attention to detail’ subscale and OEFT performance. This partially supports Grinter et al. (2009) who found an association between AQ scores and superior EFT performance. One of the suggested reasons for the discrepancy between the present study and others which have not found such an association is the cut off point for high or low AQ groups. Due to the lack of extreme scores in the current study, the high and low AQ groups were divided by the average AQ score of 15, as used by Baylis and Kritikos (2010). However, other studies which have found a relationship between autistic traits and EFT performance have used the upper and lower quartiles of scores for creating their high and low AQ groups (e.g. Almeida et al., 2010, Grinter et al., 2009).

An alternative explanation for the present study not finding evidence of WCC could be due to not controlling for IQ. Individuals with ASD and intellectual disabilities have been found to exhibit weaker central coherence, than matched controls with only ASD (van Lang, et al., 2006). Consequently, IQ could be a factor affecting WCC, in which higher performance-IQ may enable participants in the low AQ group to inhibit making an incorrect response to items that partially match the target shape on the OEFT (Grinter et al., 2009). Considering other studies that have not controlled for IQ have also failed to find evidence of WCC (e.g. Kunihira et al., 2006), further examination of the relationship between IQ and WCC needs to be investigated.

Finally, considering many other studies have failed to replicate evidence of WCC in autistic samples and subgroups (e.g. Brian & Bryson, 1996; Burnette et al., 2005; López & Leekham, 2003; Ozonoff, Strayer, McMahon, & Filloux, 1994) the possibility that WCC is not an integral feature of autistic subgroups needs to be acknowledged. With this in mind, the inconsistent results from the present study may reflect the diverse findings of the general WCC literature.

Experiment 2 found a significant correlation between higher autistic traits and negative affect, as well as participants in the high AQ group reporting more negative affect than those in the low AQ group. This is consistent with previous research and this study’s predictions (Ingersoll & Hambrick, 2011; Kunihira et al., 2006; Rosbrock & Wittingham, 2010). Negative affect and depression has been increasingly identified in individuals with ASD. Green, Gilchrist, Burton, and Cox (2000) found that in a small sample of males with Asperger's Syndrome, 40% presented with chronic unhappiness and a further 5% met the criteria for clinical depression. However, research using larger samples has suggested that depression is an even more common comorbid feature of ASD (Ghaziuddin, 1998; Kim et al., 2000; Shtayermman, 2007). In one study, percentages of children with high-functioning and low-functioning ASD presenting with irritability (88% and 84%), anxiety (79% and 67%), and depressed mood (54% and 42%) were deemed high enough for the researchers to recommend that all children with autism should be assessed for these symptoms (Mayes, Calhoun, Murray, Ahuja, & Smith, 2011). In addition to social difficulties (Lee et al., 2010), genetic factors have also been suggested to contribute towards developing depression, in which autistic children suffering from depression are more likely to have a family history of depression (Ghaziuddin & Greden, 1998).

Although no direct link between autism and depression has been identified, the two disorders seem to cluster together within families, suggesting common genetic factors may be responsible (Ghaziuddin, Ghaziuddin, & Greden, 2002). The present study's findings could also be explained by poor social relationships resulting in higher levels of negative affect in autistic populations (Whitehouse, Durkin, Jaquet, & Ziatas, 2009). Non-clinical samples with high autistic traits have been found to report more general loneliness than those with fewer autistic traits (Jobe & Williams-White, 2007). As lonely individuals seem to exhibit higher negative affect and less positive affect (Hawkley, Preacher, & Cacioppo, 2007), this could be a contributing factor in why people with high autistic traits report lower mood and lower relationship satisfaction (Pollman, Finkenauer, & Begeer, 2010). Therefore, considering the notorious presence of low mood and depression in ASD and autistic subgroups, future research focusing upon the potential cognitive consequences of negative affect may be important in explaining the underlying mechanisms of cognitive theories of ASD, as well as the aetiology of ASD itself.

Experiment 2 found evidence that lower mood predicts enhanced detail-based processing, which is consistent with the study's prediction and previous research (Avramova, & Stapel, 2008; Gasper & Clore, 2002; Schnall et al., 2008). Analysis found a negative correlation between positive affect and participants OEFT performance. Previous research comparing the PANAS to measures of depression has found that negative scores on the positive affect scale were a better predictor of depression than scores of negative affect itself, which confirms the validity of these findings (Crawford & Henry, 2004). One explanation for the effect of lower mood on local processing is based upon theories of selective attention. The 'field of view' hypothesis has been used to examine whether positive and negative states exert opposing influences on attentional selection, in which positive affect appears to impair the ability to selectively focus on a target (Anderson, 2009). This seems to be due to a fundamental shift in the 'breadth' of information processing, resulting in positive affect enhancing the scope of attention (Rowe, Hirsh, & Anderson, 2006). Conversely, negative affect appears to narrow attention, allowing more of a localised focus (Avramova, Stapel, & Lerouge, 2010b; Gasper & Clore, 2002). This is an adaptively sound concept in that negative moods may alert us to potential danger by making us more vigilant and focused, whereas positive moods may signal a safe environment resulting in broader attention (Avramova, Stapel, & Lerouge, 2010a). Although the present study did not find evidence of a correlation between negative affect and local processing, considering scores of positive affect have been found to be a better predictor of depression/low mood, the results seem significant.

Modest support was found for the present study's main hypothesis, in which participants in Experiment 2 in the high AQ group reporting less positive affect, seemed to perform better at the OEFT, compared to the low AQ group. This finding suggests that lower mood does contribute towards WCC in individuals showing high autistic traits. This finding is contrary to the results of Burnette et al. (2005) who did not find social-emotional functioning to be a factor in WCC. However, an unexpected finding emerged in which the participants in the low AQ group of Experiment 2, who reported high negative affect performed better at the OEFT than the high AQ group. Although the results in the high AQ group were statistically more robust than those found for the low AQ group, this outcome nevertheless conflicts with the previous result. These findings seem to suggest that affect does have an effect upon WCC, although the nature of its influence is not fully understood. Further investigation is needed to clarify its potential role in detail-based processing in samples with high autistic traits, using a revised methodology which takes into consideration some of this study's limitations (discussed later).

The present study found encouraging evidence for the validity and reliability of the OEFT. This new measure of the EFT was developed for the purposes of this study to provide a measure of WCC which could be used in a longitudinal study. The OEFT was based upon stimuli used by Damarla et al. (2010) and allowed results to be obtained online, without the need for participants to continuously return to a lab. An online version of the EFT has been previously developed by Yoo and Park (2006) which was called the 'Online Group Embedded Figures Test' (OGEFT). This measure was based upon the original GEFT (Oltman et al., 1971) and was used as a means of administering the GEFT over long distances via the internet. However, the OGEFT has various limitations which are primarily related to the computer skills of the participant. For instance, the OGEFT requires participants to use the computers mouse to draw around a shape, which requires a reasonable degree of motor coordination. Variations in ability are likely to affect scores as the OGEFT is a timed task, resulting in less able participants taking longer and scoring less. Furthermore, as the present study is interested in obtaining EFT scores for the purposes of studying autism, it is well established that individuals with ASD (or high autistic traits) are prone to poor motor coordination (Reiersen, Constantino, & Todd, 2008; Van Waelvelde, Oostra, Dewitte, Van den Broeck, & Jongmans, 2010). Therefore, the OEFT aimed to simplify the response criteria so that responding was not dependent upon motor abilities. Participants simply observed a stimulus containing a simple and complex figure and had to decide whether or not the simple figure was present within the complex figure by responding 'yes' or 'no'. This scale did not contain time limits either, thus compensating for participants with less computer skills who may take longer. When OEFT scores were compared to GEFT scores in Experiment 1, a significant moderate correlation was found suggesting good construct validity. Furthermore, tests of inter-item analysis found the OEFT to be internally consistent.

In Experiment 2, the OEFT was divided into four parts, in which each part significantly correlated with each other, which is another indicator of internal reliability. Future studies using the OEFT should focus upon repeated testing to further establish reliability, the potential effect of introducing time limits, and item-total correlations to establish which items are the best predictors of EFT performance, in an attempt to produce a more concise and accurate scale. The results from the present study suggest the OEFT is an effective and reliable measure of detail-based processing, which could have wide-spread future applications.

The present study has numerous limitations. First, as the mood manipulation in Experiment 1 was not successful in inducing participants into the required affective states, any results relating to mood lack validity. Consequently, a more established mood-inducing technique should be employed in future research, which is more suited to inducing negative states. One such technique is the use of film clips which have proved effective in eliciting sadness in participants (Coan & Allen, 2007). Gross and Levinson (1995) have produced a database of film clips which have been repeatedly tested and found to be particularly effective in eliciting specific emotional states, including sadness. Furthermore, they collated affective scores for each film which can be used as a baseline for comparison. This could be useful in avoiding another potential limitation of this study, which was the repeated presentation of the PANAS.

As participants completed the PANAS before and after the mood manipulation, it seems possible that participants simply recreated their scores from the first PANAS, irrelevant of mood. Using the film technique, participants could rate their affective state after the mood manipulation and then compare this score to the baseline score, excluding anyone who did not meet the affective criteria (Coan & Allen, 2007; Gross & Levinson; 1995). Another limitation was the high dropout rate and lack of completion of all four trials of Experiment 2. Consequently, complete sets of results were not obtained for most participants. Participant dropout in online research using undergraduate students has been found to be a problem with this methodology, in which 10% of participants can often be expected to drop out almost immediately and another 2% dropping out for every 100 items of survey content (Hoerger, 2010). To ensure participants complete each part of the study in future research, further incentives may need to be introduced which are tailored to increase the motivation of the respondent (de Leeuw, 2005). Participants were each awarded one participation point for completing all four parts of the study, which in total, is less than the usual 30 minutes needed to gain a point. However, as the study involved participation over an extended period of time, this may not have acted as enough of an incentive for continual involvement. Therefore, future research may benefit from awarding participation for each trial completed, which although not as cost effective, may help counteract the lack of incentive for longitudinal participation.

Another solution which would also address some of this study's other limitations would be recruiting a larger sample of participants in future research. Firstly, this would help to counteract the effects of excessive dropout. Second, when using correlational analysis it is good practice to have at least 100 participants to prevent extreme scores from skewing the data (Brace, Kemp, & Snelgar, 2006). Third, gender difference could not be adequately explored due to limited male participants available in the participation pool (male = 27.6%, female = 72.4%). Although Experiment 1 recruited a reasonable number of males (n=22) compared to female participants (n=34), Experiment 2 only recruited 8 males in contrast to 56 female participants. Therefore, considering the ineffective mood manipulation of Experiment 1 and the lack of males in Experiment 2, gender differences could not be adequately

explored. Forth, if more participants were recruited, it is reasonable to assume that a greater range of AQ scores would be obtained. This would allow for participants to be divided into high and low AQ groups according to the upper and lower quartiles of AQ scores, which previous research has found to result in producing evidence of WCC in a non-clinical population with autistic traits (e.g. Almeida et al., 2010; Grinter et al., 2009). Due to the lack of variability in this study's AQ scores and only a few participants having scores in the higher/lower limits, this methodological approach was not possible. The final limitation of the present study is that as conclusive evidence of WCC was not found in participants reporting high autistic traits, it is questionable about how applicable these findings are to an autistic population.
To conclude, the present study found some support for previous research and suggests that affect does have some influence on WCC in individuals with autistic traits, although the nature of its influence is not fully understood. Even so, the results from this study have important implications for future research, which may help reveal if mood is a factor in whether autistic people see the forest, or the trees.

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